PATENT SPECIFICATION

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NO DRAWINGS.

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COMPLETE SPECIFICATION.

A Copper Casting Alloy.

We, ZENTRALINSTITUT FUR GIESSEREITECHNIK, of 24, Gerhard-Ellrodt-Strasse, 7034 Leipzig, Germany, a Corporation organised under the laws of Eastern Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention is concerned with a copper casting alloy which is characterised by high ultimate stress values, as well as by a remarkable resistance to cavitation and corrosion, especially against sea water and, therefore, is especially useful for ships' propellers, constructional parts of ships, parts of pumps, calander rollers and the like.

Copper casting alloys are already known which, besides the main alloying element zinc, also contain small additions of aluminium, iron, manganese and, possibly, nickel and which, because of their good metallurgical and technological properties, such as low melting temperature, low gas solubility and a lack of sensitivity to hydrogen porosity occasioned thereby and good welding and working properties, find a wide field of application as special brasses, especially in shipbuilding. However, with regard to their static and dynamic strength, as well as their resistance to cavitation and corrosion, these alloys are inferior to the known aluminium multi-component bronzes which are, nevertheless, more difficult to use from a metallurgical point of view.

[*Price* 4*s*. 6*d*.]

In an endeavour to improve the corrosion resistance of special brasses containing zinc, aluminium, manganese and iron, nickel was added to these alloys. Thus, for example, for the production of ships' propellers, there has been used, to a wide extent, an alloy which, besides 59.3% copper, 35% zinc, 1.3% iron, 2.6% manganese, 0.92% aluminium and 0.35% tin, also contained 0.5% nickel. The tensile strength of this alloy is 50.4 kp/mm², the 0.2 tensile limit is 26.7 kp/mm² and the breaking elongation is 27.2%.

For the same purpose, there is also known an alloy which contains 56—58% copper, 37—41% zinc, 1.1—1.3% aluminium, 0.9—1.1% iron, 0.5—1.0% manganese and 0.5% tin, as well as about 1% nickel. Starting from this composition, the nickel content of the alloy is increased to 2% for armatures which are subjected to corrosive conditions. The nickel content of an alloy which is used, in particular, for turbine parts, even amounts to as much as 3%.

The corrosion resistance of the nickel-containing alloys is said to be 2.5 times greater than that of the nickel-free alloys. However, a significant improvement of the ultimate stress values is not obtained by the addition of nickel. In order to take into account the requirements which arise in practice, it is endeavoured to obtain a tensile strength of 60 kp/mm², with a simultaneous elongation of 20%, these values being the minimum requirements.

Experiments directed towards finding an alloy which possesses a high strength and a high elongation with, at the same time, more favourable resistance to corrosion and cavitation, showed that, with a decreasing zinc content, the corrosion resistance increased, whereas an increasing of the proportion of aluminium improved the tensile strength but, at the same time, impaired the elongation. A corresponding, known alloy has the following constitution: 62% copper, 26% zinc, 5.5% aluminium, 3.5% manganese and 3.0% iron. In the case of this alloy, it is to be noted that the tensile strength achieved is 81 kp/mm² and the 0.2 tensile limit is 49 kp/mm², whereas the breaking elongation of 15% does not meet the practical requirements. For parts which are subjected to dynamic stresses, such as oscillations and impacts, this alloy is less suitable than one with better plastic properties.

To another type of copper casting alloys, there belong the aluminium multi-component bronzes which are characterised by high ultimate stress values and good resistance to corrosion and cavitation but have the disadvantage of high melting temperatures and, consequently, are metallurgically more difficult to use. By variation of the composition of these bronzes, especially by increasing the content of manganese, an attempt was made to obtain lower melting temperatures while retaining the desirable properties and while simultaneously significantly lowering the known tendency of these alloys to take up gas. A known alloy of this type has the following constitution: 10—15% manganese, 6.5—9% aluminium, 2—4% iron, 1.5—6% nickel and at least 70% copper.

A similar alloy is also known with 8—9% manganese, 8.5—9.5% aluminium and small amounts of iron and nickel. Good mechanical properties can be achieved with a constitution of 15—35% manganese, 3.5—9.5% aluminium, 2—4% iron and 0—6% nickel, the remainder being copper, insofar as manganese of high purity is used. However, the carbon content of this alloy should be less than 0.02% since, in the case of higher carbon contents, a very marked regression of the toughness is observed. In practice, however, this requirement is difficult to fulfil.

Apart from a reduction of the tendency to gas porosity, it has not been possible, by the variation of the aluminium multi-component bronzes, to achieve the outstanding casting properties of the special brasses. Furthermore, these bronzes exhibit a more or less great permeability which is undesirable, for example, for certain fields of use in ship-building.

It is an object of the present invention to overcome the disadvantages associated with the known brasses, especially the special brasses, as well as the aluminium multi-component bronzes.

The problem which forms the basis of the present invention is to provide a copper casting alloy which is particularly suitable for the production of parts which are subjected to considerable chemical and mechanical stresses and which combines the good properties of the aluminium multi-component bronzes, such as high strength, good resistance to corrosion and cavitation, as well as the low melting temperature, low gas solubility and low hydrogen porosity occasioned thereby, of the special brasses.

According to the present invention, this problem is solved by the provision of an alloy of the composition 9—18% manganese, 7.1—12% zinc, 4.5—7.5% aluminium, 0.05—4% nickel and 1—3% iron, the balance of the alloy, apart from impurities, being copper in an amount of at least 65%. The ratio of manganess to zinc is preferably 2:1.

We have found that the new alloy according to the present invention can contain up to 0.06% carbon without this comparatively high carbon content impairing the properties of the alloy when there is added to the alloy up to 0.25%, preferably 0.05—0.15%, titanium. It is thereby possible, by the adjustment of the necessary manganese content, to make use, wholly or partially, of cheaper ferro-alloys.

The amount of silicon, which may possibly be present in copper casting alloys, is less than 0.2%, since otherwise there may arise not only a reduction of the breaking elongation but also a reduction of the tensile strength and of the 0.2 tensile limit.

In the case of a variation of the individual alloy components, these should be maintained an exchange coefficient of manganese to aluminium such as 6:1 and of zinc to aluminium such as 5:1. In other words, this means that insofar as, in the case of a given alloy composition, a deviation of the concentration of one or more of the elements manganese, aluminium and zinc from the intended concentration is ascertained by, for example, a rapid analysis during the melting process, then one or two of the mentioned elements can be replaced by the third element, while maintaining the exchange coefficients, insofar as the content of the individual elements lies between the minimum and maximum contents applicable for the alloy according to the present invention.

Depending upon the composition of the alloy, there can be achieved ultimate stress values between:

80 kp/mm² tensile strength
58 kp/mm² 0.2 tensile limit
10% breaking elongation
230 Brinell units, and

55 kp/mm² tensile strength
25 kp/mm² 0.2 tensile limit
48% breaking elongation
120 Brinell units.

Cavitation experiments showed that the alloy according to the present invention is far superior, with regard to stability, to the typical casting special brasses used for parts in shipbuilding. We have found that the wear resistance values lie within the range of the values achieved with the aluminium-manganese bronzes and the nickel-aluminium bronzes.

Besides the outstanding static and dynamic strength properties, the alloys according to the present invention exhibit casting properties which approximate to those of the casting special brasses. In comparison with the casting special brasses, there is the further advantage of a low density of about 7.6 kg/dm^3, in contradistinction to one of about 8.6 kg/dm^3, which results in a considerable saving of material.

The permeability of the alloy according to the present invention is, in comparison with the aluminium-manganese bronzes, so small that it can be regarded as being almost non-magnetic.

The following Example, which is given for the purpose of illustrating the present invention, is of a composition which is especially suitable for ships' propellers:—

EXAMPLE 1.

An alloy was made with the following composition: 72.6% copper, 10.2% manganese, 6.0% aluminium, 7.1% zinc, 2.1% nickel and 2.0% iron. The mass loss is 0.894 (g.). The tensile strength of this alloy is 64 kp/mm^2, the 0.2 tensile limit is 26.5 kp/mm^2, the breaking elongation is 27.5% and Brinell hardness is 175.

WHAT WE CLAIM IS:—

1. A copper casting alloy which is especially suitable for parts subjected to heavy mechanical and chemical stresses, which comprises 9—18% manganese, 7.1—12% zinc, 4.5—7.5% aluminium, 0.05—4% nickel and 1—3% iron, the balance of the alloy, apart from impurities, being copper in an amount of at least 65%.

2. A copper casting alloy according to claim 1, wherein the ratio of manganese to zinc is 2:1.

3. A modification of the copper casting alloy according to claim 1 or 2, which additionally contains up to 0.25% titanium.

4. A copper casting alloy according to claim 3, wherein the titanium content is 0.05—0.15%.

5. A modification of the copper casting alloy according to any of the preceding claims, which additionally has a silicon content of less than 0.2%.

6. A copper casting alloy according to claim 1, substantially as hereinbefore described and exemplified.

7. Parts which are subjected to heavy mechanical and chemical stresses, whenever made from a copper casting alloy according to any of claims 1—6.

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